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Ecology of Martens in Southeast Alaska

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This is a progress report on continuing research. Information may be refined at a later date.

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RESEARCH PROGRESS REPORT

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PERIOD: 1 July 1997–30 June 1998

SUMMARY

During the final year of fieldwork on this project, we captured 50 martens (*Martes americana*) (32 males and 18 females) on the Salt Lake Bay study area and 23 martens (15 males and 8 females) in Upper Game Creek, on northeast Chichagof Island. At Salt Lake Bay, we radiocollared 3 new male martens and 6 other animals (3 males and 3 females) previously eartagged. At Game Creek, we radiocollared 2 previous captures (2 females) and eartagged 14 others. We monitored 33 martens (22 males and 11 females) part of the year and recorded habitat use at 200 aerial locations.

During late spring, we monitored 7 adult females closely to locate den sites, and we found the den sites of 5 of these females, including 8 natal and 8 maternal dens. Of the 15 natal dens located since 1994, 4 were in cavities in live trees, 3 were in snag cavities, 5 were in hollow logs, and 3 were in root cavities. Diameters of these structures ranged from 60 to 148 cm. Of the 14 maternal dens located, 8 were in root cavities beneath live trees or snags, 4 were in hollow logs, and 2 were in logging slash. Diameters of used structures ranged from 50 to 150 cm. Martens used more live trees as resting sites in summer than in winter, and males often rested on the ground among dense understory vegetation in summer. In winter, martens most often rested in root cavities, snags, and underground sites.

We measured habitat attributes at the den and resting sites to examine microhabitat use. In addition, we measured habitat attributes at 24 random sites to estimate their availability and evaluate a new landcover map developed from LANDSAT TM imagery.

The snap-trap index indicated small mammal numbers decreased about 40% from fall 1996. The index decreased for the third year in a row from a high of 26.9 captures/100 trap nights in 1994. The abundance of deer mice remained about the same, but the catch of long-tailed voles decreased 82% (5.1 to 0.9 captures/100 trap nights).

Key words: Chichagof Island, demographics, forestry, habitat use, martens, *Martes americana*, modeling, old-growth forests, population biology, Southeast Alaska

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BACKGROUND

We completed an eighth and final year of ecological fieldwork on martens in Southeast Alaska. In this report, we present a summary of information collected on each of the 10 specific study jobs during 1 July 1997 to 30 June 1998. During this report period, we primarily studied marten population dynamics and microhabitat use at den and resting sites. In addition, we finished our assessment of the availability of habitat attributes on the study area, including an evaluation of the available landcover maps. Periodically, we live-trapped and tagged martens on the primary study area on northeast Chichagof Island. We monitored tagged martens to collect information on movements, demography, and habitat use. We collected additional demographic information from martens caught by trappers on northeast Chichagof Island.

American martens (*Martes americana*) have been associated with late-succession and old-growth forests across North America (Buskirk and Ruggiero 1994). Martens are among the most habitat-specific mammals in North America (Buskirk and Ruggiero 1994). In western North America, they are closely tied to mesic, old-growth, coniferous forests (Marshall 1951, Koehler and Hornocker 1977, Thompson and Harestad 1994). Old-growth forests are structurally diverse with a variety of tree sizes, dense multilayered canopies, and an abundance of coarse woody debris (CWD) (i.e., snags, stumps, and downed logs) (Samson et al. 1986, Boughton et al. 1991). Many marten populations have declined with the removal of forested habitat, increased human access, and unrestricted trapping (Clark et al. 1987). In Southeast Alaska, the Tongass National Forest (TNF) encompasses 80% of the land area. Although most of the original forested land was in an old-growth condition, industrial scale logging has converted large areas of old-growth forest habitat into clearcuts and second growth. About 162,000 ha (400,000 acres) of old-growth habitat have already been logged on the TNF, nearly all by clearcutting. The new, revised Tongass Land Management Plan (TLMP) schedules an additional 274,000 ha (676,000 acres) of old-growth forests for timber harvest (USDA Forest Service 1997). The clearcutting of old-growth forests removes the forest canopy along with all above-ground structures including decadent live trees and snags that are important components of marten habitat.

Martens select for old-growth features when choosing reproductive den sites (Ruggiero et al. 1998) and resting sites (Wilbert 1992). Marten dens are any structure occupied by a mother and young (Henry and Ruggiero 1993), and resting sites are structures where independent martens rest between bouts of activity (Buskirk et al. 1989). Henry and Ruggiero (1993) described 2 types of dens. Natal dens are sites where kits are born, and maternal dens are all other dens occupied by the mother and kits. Large trees and CWD provide martens with cover from predators (Vernam 1987, Lindstrom et al. 1995) and inclement weather while resting (Buskirk et al. 1989, Martin and Barrett 1991) or denning (Hauptman 1979, Wynne and Sherburne 1984, Baker 1992, Ruggiero et al. 1998). Spaces under CWD provide access to subnivean foraging areas (Corn and Raphael 1992) and resting sites (Buskirk et al. 1989, Taylor and Buskirk 1994). Adequate availability of structures for denning and resting is probably important for marten survival.

Clearcutting, the predominant method of tree harvesting in western North America (Franklin and Forman 1987, Vance 1990), negatively affects martens (Bergerud 1969, Campbell 1979, Major 1979, Soutiere 1979, Clark et al. 1987, Snyder and Bissonette 1987, Bissonette et al. 1989, Jones and Raphael 1992, Thompson and Harestad 1994). In typical clearcuts, structures important to martens, such as live trees and snags, are felled. Although an abundance of CWD may exist immediately after clearcutting, the amount and size of CWD will decline as the slash and residual CWD decay (Franklin and Waring 1980, Tritton 1980). Because all trees have been removed, new large CWD will not be recruited into the stand with a 100-year timber rotation. Martens generally avoid areas with little overhead cover (Buskirk and Ruggiero 1994), and abundant CWD in recent clearcuts probably is of little value to them. However, martens will use residual CWD in second-growth stands (Baker 1992), but how long these structures will remain useful to martens is unknown. Highly decayed CWD probably provides less value to martens (Wilbert 1992). New logs or snags of sufficient size to accommodate marten dens or resting sites may require over 200 years to grow (Harris 1984, Franklin et al. 1981). Currently planned 100-year timber rotation times on managed forests will not permit the formation of large CWD before the next cutting (USDA Forest Service 1997).

Martens are the focus of the fur industry in Southeast Alaska; the annual harvest has averaged 2770 animals between 1984 and 1996 (ADF&G unpubl. data, Douglas). Trappers consistently report that martens are the most important species to them (ADF&G Trapper Questionnaire Statewide Report 1997). Because forest management activities were expected to affect population abundance and because pelts represent significant economic value to local residents, martens were selected as a management indicator species (MIS) for the revision of the TLMP (Sidle and Suring 1986). Although old-growth forests were identified as a special habitat, more information is needed on the specific habitat components used by martens. The TLMP (USDA Forest Service 1997) contains standards and guidelines for managing marten habitats on Forest Service lands. These standards require the retention of forest features important to martens in timber harvest areas, particularly in areas heavily affected by timber harvest. Additional information on forest features used by martens for denning and resting will be needed for evaluation of the standards.

Density of marten populations has been linked to habitat quality (Soutiere 1979), specifically the availability of late succession forest features (Campbell 1979, Thompson and Harestad 1994). Island populations are naturally more vulnerable to extirpation because they are not augmented by immigration. When isolated marten populations are subjected to habitat degradation, densities may fall to the point that inbreeding, genetic drift, and stochastic events may contribute to extirpation (Buskirk and Ruggiero 1994). This has already occurred on Cape Bretton Island, Nova Scotia, and martens are threatened on Newfoundland (Gibilisco 1994). In western North America, martens have been extirpated from the Tobacco Root Mountains of Montana, and isolated populations in northern California and the Olympic Peninsula are threatened (Buskirk and Ruggiero 1994).

OBJECTIVES

This research was designed to describe the habitat and population ecology of martens on northeast Chichagof Island. The information from this study will be used to evaluate the interagency habitat capability model.

The specific study objectives (Jobs 1–8) are listed below.

1 Determine seasonal habitat use and selection patterns of a sample of martens living in logged and unlogged landscapes at the microsite, stand, and landscape level;

2 Determine the composition of habitats within the northeast Chichagof Island study area;

3 Evaluate the interagency habitat capability model;

4 Determine the demographic characteristics of marten populations on northeast Chichagof Island;

5 Determine marten movement and spatial patterns of martens on northeast Chichagof Island;

6 Determine the relative abundance of small mammal prey within the Chichagof Island study area;

7 Determine the seasonal diets of martens on northeast Chichagof Island; and

8 Evaluate whether the skull size criteria developed by Magoun et al. (1988) correctly classify Southeast martens by sex and age.

STUDY AREA

We chose northeast Chichagof Island for the study because its topography and habitats were typical of northern Southeast Alaska. In addition, logging roads provided good access, part of the area had been logged, camp facilities were available at a Forest Service float house, and the area was relatively close to Juneau. The primary study area comprised lands adjacent to Salt Lake Bay (58° 56' N, 135° 20' E), located about 90 km (56 miles) west of Juneau and 26 km (16 miles) south of Hoonah (Fig. 1). The Salt Lake Bay study area (125 km^2) was bounded by Port Frederick to the north, Tenakee Inlet to the south, the portage (a narrow strip of land between the large water bodies) on the west, and the Game Creek and Indian River drainages on the east and north. In 1992 we extended the study into the upper Game Creek watershed (102 km^2), located north of Salt Lake Bay. Most of the study area was under the jurisdiction of the USDA Forest Service within the Chatham Area, Tongass National Forest. Habitats in the study area were further described in Flynn (1991).

About 7% of the Salt Lake Bay study area was logged from 1984 to 1988 and 27 km of logging roads were constructed. An additional 486 ha were clearcut from 1990 to 1992 (USDA Forest Service 1989). Logging activity began in June 1990 with the construction of about 10 km of logging road. Two units were felled before a court injunction suspended all logging activity at the end of June 1990. The court lifted the injunction during August 1991, and logging resumed September 1991. Logging activity continued until 10 December 1991; nearly one half of the units were felled. Logging activity was suspended for the winter and resumed in April 1992. All logging activity in the Salt Lake Bay area was completed 31 October 1992.

The upper Game Creek watershed was the last major unlogged watershed on northeast Chichagof Island. Road building in the upper Game Creek drainage began in April 1992 with the construction of 1 bridge across the North Fork and 2 bridges across Game Creek. Road building continued at a rapid pace for the remainder of the year, and most of the planned road system was completed by winter. All the low-elevation cutting units were felled during summer and fall. During spring 1993 road building continued into the upper watershed of adjacent Seagull Creek, and the remaining upper-elevation units in Game Creek were felled during 1993 and 1994. All of the logging activity was completed during 1995.

Recreational and subsistence trapping seasons for martens, mink, and weasels on the northeast portion of Chichagof Island were closed for the 1990–1991 regulatory year because of depleted marten populations. The portion of northern Chichagof Island west of Port Frederick remained open with season dates from 1 December to 15 February. The trapping season for both portions of northern Chichagof Island opened on 1 December for the 1991–1992 season. On northeast Chichagof Island, a federal subsistence regulation prohibited trapping with the use of a motorized land vehicle on federal lands. The trapping seasons for marten, mink, and weasels were closed by emergency order on 24 January 1992 because of concern about overharvest of martens. During the 1992–1993 season, marten trapping on northern Chichagof Island was allowed only during December. The prohibition of trapping with the use of a motorized land vehicle on federal lands by federal subsistence regulation was extended to cover the west side of Port Frederick. For the remainder of Unit 4, the marten trapping season ran from 1 December to 15 February with no additional restrictions. During 1993–1994 marten trapping seasons remained the same as the previous year's seasons.

For 1994–1995 the Federal Subsistence Board closed the recreational and subsistence trapping seasons for martens, mink, and weasels on Chichagof Island on federal lands because of low marten numbers. The state season on nonfederal lands remained the same, a 31-day season on northeast Chichagof Island during December and a 75-day season on the remainder of Chichagof beginning December 1. For 1995–1996 the Federal Subsistence Board established a 31-day trapping season, opening on December 1, for federal lands on Chichagof Island and prohibited the use of motorized land vehicles for trapping. During 1996–97 state trapping seasons remained the same as the previous seasons. All trapping regulations for the study area remained the same for the 1997–1998 seasons.

METHODS

Most study jobs required the capture and radiocollaring of a sample of martens on the primary study area. Martens were live-trapped throughout the year at permanent trap sites systematically located along the logging road system. Trap sites were usually about 500 m apart. Traps (Models 203 and 205, Tomahawk Live Trap Co., Tomahawk, WI) were baited with either strawberry jam, sardines, or venison scraps, covered with a green tarp, and placed under a log or the base of a tree at trap sites. We checked the traps daily. Captured martens were pressed in the end of the trap using a folded blanket and injected with a mixture of 18.0 mg/kg ketamine hydrochloride (Vetalar) and 1.6 mg/kg xylazine hydrochloride (Rompun) for immobilization. For short-term chemical restraint, we used a dosage of 13.0 mg/kg of ketamine and 1.0 mg/kg xylazine. All captured martens were eartagged (Size 1, Style 1005, National Band and Tag Co., Newport, KY), sexed, weighed, and measured. Two first premolar teeth were pulled for age determination by cementum analysis (Matson's Laboratory, Milltown, MT). We drew a 3.0 cc blood sample from the jugular vein from most captured animals, separated the serum, and then froze both portions for future analyses for disease, diet, and pregnancy studies. We radiocollared some of the captured martens, primarily adults previously captured on the study area. On female martens, we used 2 radio collar types; each weighed about 35 g with an expected life of 12 months (Telonics MOD-073, Telonics, Mesa, Arizona USA and Lotek SMRC-4, Lotek Engineering, Newmarket, Ontario CAN). On males, we used a 49-g collar (Telonics MOD-080, expected life of 12–18 months). After a marten had recovered from the immobilization, we released it near the capture site. Martens recaptured during the same trapping session were released without additional processing. During subsequent trapping sessions, all recaptures were chemically restrained, weighed, and measured. We replaced collars on several animals throughout the year.

We considered radiocollared martens that showed fidelity to a home range area a resident animal. Martens that moved over an area >2 home ranges within a season and covered areas occupied by other resident martens, were labeled transients. We classified martens more than 1-year-old as adults. Young-of-the-year animals, or birth-year martens, were called juveniles.

JOB 1. HABITAT USE

We located radiocollared martens from small aircraft (Mech 1974, Kenward 1987) during daylight hours throughout the year. Usually we used a Piper Super Cub aircraft. After we located an animal by circling in the aircraft, we plotted the marten’s location on paper copies of high-resolution orthophoto maps (1:31,680 scale). We also described the habitat at each location while in the aircraft according to USDA Forest Service definitions of timber volume class, stand size class, old-growth forest type, and physiographic location (riparian, upland, beach fringe, estuary fringe, subalpine, or alpine). At the office, we transferred the locations to mylar overlays on color aerial photographs (1:15,840 scale) for a permanent record. The locations were plotted on digital versions of the orthophoto maps using geographic information system (GIS) software (ArcView 3.0a) on a personal computer. Additional attribute information for each location was recorded from the orthophoto maps, including elevation, slope, and aspect and entered into the attribute file.

We will determine habitat selection by comparing the proportionate use of habitats with their availability (see Job 2) in the study area (Neu et al. 1974, White and Garrott 1990). Data collected from September through May represented habitat use during the fall/winter/spring season. In future analyses, the habitat use of each animal will be compared with the availability of habitats within its home range area and the primary study area. A Chi-squared goodness-of-fit test will be used to test the null hypothesis that habitats were used by martens in proportion to their availability. If the null hypothesis is rejected, then each habitat will be evaluated separately for selection using Bonferroni normal statistics (Neu et al. 1974, Byers and Steinhorst 1984, White and Garrott 1990). Manly's measure of preference (Manly et al. 1972, Chesson 1983) will be computed for each habitat category to characterize the degree of selection of a particular habitat.

Marten Den/Resting Sites

If we located an adult female marten at the same place 3 or more times during the May to June denning period, we assumed it was at a den. We located the den structure by ground-tracking the female to the site when constant strength and location of radio signals indicated the target marten was stationary. We found resting sites in a similar manner. Dens were distinguished from resting sites by their repeated use over several days or weeks and by the presence of latrines or prey remains. Resting sites were defined as sites occupied by a marten for at least 30 minutes. All the dens and resting sites were flagged in the field and marked on aerial resource photos. We digitized site locations on digital orthophotos to create a GIS point coverage. Each den/resting site was buffered with a 62-m radius circle to create a polygon coverage of the area around the site. We revisited the sites after the martens had abandoned the dens or left the immediate area. We measured habitat attributes within the polygons, using the same procedures as described below for random sites. The center plot was centered on the den/resting site.

JOB 2. HABITAT COMPOSITION

The composition of the study areas will be determined from US Forest Service GIS databases. We now have a library of GIS data files from US Forest Service staff including landcover, timber type, soils, land status, streams, elevation, clearcuts, and roads. We will consider the proportional area of habitats in the analysis area our measure of habitat availability. To evaluate landscape-level effects, we will collect additional landscape attributes such as roads, corridors, stand size, and composition. This information will be further analyzed with GIS software for the final report in 2000.

Because of problems with the accuracy of the timber-type map, we continued working with USDA Forest Service staff on evaluating LANDSAT TM satellite technology for mapping landcover in Southeast Alaska. We are hopeful that this technology can provide an improved map of habitats on the study area. In 1995 the USDA Forest Service contracted with Pacific Meridian Resources to produce 3 landcover maps of northern Southeast Alaska using LANDSAT TM imagery (Pacific Meridian Resources 1995). The map types were size/structure, tree species, and canopy cover. The size/structure type was developed to distinguish forest stands by their density of trees by size class and to separate multistoried canopies from singlestoried.

To collect information about habitat attributes of the landcover types, we visited random sites (stratified by the size/structure map) in the field and measured numerous habitat attributes. We selected the size/structure map for further evaluation because we believed the size/structure map best represented structural features of the forest. Habitat attributes included the density of live trees by size class, the density of snags by size class, the amount of down wood by size class, and the amount of understory. Forest structure provides important habitat components for wildlife species associated with forests, especially old-growth associated species (Sidle and Suring 1986). Because size/structure is usually correlated with the amount of overstory canopy closure, the size/structure map also provided us with a measure of canopy cover. We also collected data on the tree species map but did not include it because this project was not specifically designed to evaluate this map.

In addition, we collected information on the accuracy of the landcover maps. Our 1996 field data were provided to USFS staff and combined with their data for additional accuracy assessment (AA) evaluations (Fehringer 1997). We present additional AA information here based on a combination of our 1996 and 1997 data.

SAMPLE SELECTION

Random Sites

The size/structure map developed from LANDSAT TM imagery by Pacific Meridian Resources (1995) for northern Southeast Alaska was used to define map strata. For this evaluation, we collapsed the 17 size/structure categories into 5 forest strata and 3 nonforest strata for 8 strata (Table 1). The multistoried categories were large/multistoried (Large/MS), (Medium/MS), intermediate/multistoried (Intermediate/MS), and a combined small/multistoried and pole/multistoried class (Small/MS). We collapsed all of the single-storied classes into a single category called singlestoried because the single-storied classes represented only a small proportion (3.6%) of the study area (Table 1). The three nonforest strata were shrub, other nonforest (combined herbaceous, sparsely vegetated, and snow), and "recent clearcuts" (<15 years old). Because we thought recent clearcuts represented a specific habitat condition with known boundaries, we used the USFS GIS coverage for this stratum. Because many of the clearcuts were more recent than the 1992 satellite imagery, they had been mapped incorrectly as forested types. Collectively, this stratum had been mapped as Other nonforest (6.4%), Shrub (34.0%), Large/MS (12.9%), Medium/MS (21.2%), Intermediate/MS (7.4%), Small/ MS (3.8%), and Singlestoried (9.1%). Pre-1992 clearcut areas had been mapped mostly as shrub and older clearcuts were mostly mapped as singlestoried.

A polygon coverage (GIS) was created from the raster landcover map by grouping similar and adjacent pixels into polygons (Gary Fischer, USFS Juneau, pers commun). We selected a random sample of 8 polygons within each stratum for field sampling (64 polygons). Only polygons at least 1.2 ha (3 acres) in size and within 0.6 km (0.4 mile) of the road systems at Salt Lake Bay or upper Game Creek were eligible for selection. Additionally, a 1.2-ha circle needed to fit completely within the polygon (Fig 2). Using GIS software, we printed the selected polygons on digital orthophoto maps and transferred them to resource photos (1:15,840), using the digital orthophoto maps for reference. We determined compass bearings and distances from known landmarks to the polygon centers from the digital orthophotos.

We designed this project to provide an evaluation of the LANDSAT TM map while minimizing costs. We restricted field sites to within reasonable walking distance (0.6 km) of access roads because funding for helicopter transport was unavailable. Some of the sites still required considerable effort because of crossing steep terrain. Volunteers were used extensively for field personnel, especially in 1997 after funding for field assistance was unavailable. We found that a field crew of four members worked most efficiently. One person measured the site attributes and recorded all of the plot data while two people measured trees. A fourth person completed the overstory canopy cover sheet and recorded logs. Usually, we completed 2 sites each day instead of the projected 3-4 sites. To maintain consistency, only 1 field crew was used at a time, and the same persons (R. Flynn or T. Schumacher) made the overstory estimates and completed the plot forms.

DATA COLLECTION

A field crew located the polygons on the ground by walking the bearing and distance from known landmarks. We also used resource photos and a hand-held global positioning system (GPS) device to locate some plots. At each site, we estimated canopy cover by tree size class for the polygon, using the procedures established for training and accuracy assessment sites (Pacific Meridian Resources 1995). We used the same data sheets and criteria to determine the correct map labels for the polygon, including size/structure, species, and canopy cover. In addition, several site attributes were recorded near the polygon's center, including elevation (altimeter), aspect (compass), and slope (clinometer).

The vegetative characteristics for the polygon were measured using a cluster-sampling procedure similar to the USFS GRID project (USDA Forest Service 1995). Four sample points were established in each polygon. The first sample point was established near the polygon's center. We determined the location of this first sample point by pacing from the edge of the polygon toward its center, a distance equal to the radius of the polygon. Sample point 2 was located 36.6 m north of point 1, point 2 was located on a 120°-azimuth 36.6 m from point 1, and point 4 was located on a 240°-azimuth 36.6 m from point 1.

A single, 7.3-m fixed-radius plot was established around each sample point to measure tree, snag, and down wood attributes. For each tree >12.5 cm in diameter (live and dead), we recorded the species, height, diameter (dbh), status (whether live or dead), crown class, and decay category. We noted other habitat attributes such as elevated roots, squirrel middens, extensive cavities, etc. Instead of using transects to measure down wood, we recorded all logs within the plot including its species, length within the plot, diameter of each end, and decay class. Dead trees were considered snags.

A single, 5.64-m fixed-radius plot was established around the sample point to measure the understory. The composite cover of each shrub and herb species was estimated along with the average height of the shrub layer. A single, 2.0 m radius fixed plot was established around the sample point to count all seedlings and saplings (trees<12 cm) by species.

DATA ANALYSIS

All data were recorded on paper forms in the field. We obtained a data-entry program developed by USFS GRID project staff (USDA Forest Service 1995) to input the plot attribute data into a personal computer. Thus, our data structures and formats would be similar to their data set. For our analyses, we converted the tree data into an SAS data set, using SAS statistical software (SAS Institute 1996).

We assigned landcover labels to the random sites, using criteria developed by Pacific Meridian Resources (1995). We evaluated map accuracy by comparing the field labels for sites to the map labels, using an error matrix approach (Pacific Meridian 1995). The numbers of exact matches were tallied by landcover strata and expressed as the percentage classified correctly. In addition, an "acceptable" call was assigned to each field site using a "fuzzy logic" approach described by Pacific Meridian (1995). An acceptable call was given if the site was close (i.e., within 10% canopy cover) to the adjacent category. The numbers of acceptable matches were also tallied by landcover strata and expressed as the percentage classified correctly.

The den/resting site polygons were intersected with the size/structure polygon map to determine their composition by mapped landcover strata. Usually these polygons consisted of several pixel types. A size/structure map label was assigned to each polygon, based on the labeling rules described by Pacific Meridian (1995).

For this evaluation, a tree was defined as a live or dead tree greater than 230 mm (9 in.) diameter at breast height (dbh) and taller than 2 m (6.6 ft). Thus, the tree data included live trees and snags, but not stumps. We computed 4 tree size-class variables from the field data for each site. We used the same dbh breaks to create tree size classes as were used to develop the size/structure map classification (Pacific Meridian 1995). We defined large trees as trees/snags greater than 820 mm (32.0 in.) dbh, medium trees were from 590 to 819 mm (23.0–31.9 in.) dbh, intermediate trees from 385 to 589 mm (15.0–22.9 in.) dbh, small trees from 230 to 384 mm (9.0–14.9 in.) dbh, and pole trees 125 to 229 mm (5–9 in.) dbh.

At each site, we summed the number of trees in each size class for the 4 subplots. Thus, the total area sampled at each site was 0.067 ha (0.165 acre), or 5.5% of the 1.2-ha polygon. Descriptive statistics (means and SEs) for the tree size-class variables were computed for each strata using SAS statistical software (SAS Inst. 1996). Separate sets of statistics were calculated for the random sites, den/rest sites, and combined data sets. The random and den/rest sites were compared with a series of *t*-tests of the tree-class variables by strata. Because none of the strata was significantly different (alpha = 0.05) between the site type for any tree-class variable, the random and den/rest sites were pooled for the rest of the analyses. In addition, the shrub, recent clearcut, and other nonforest strata were combined into a single, nonforest stratum because these strata had few trees.

Differences among size/structure strata were evaluated for each tree size-class variable using a series of one-way analysis of variance tests (ANOVA) (SAS Institute 1996). We tested the hypothesis that the means for a tree-class variable were the same for all the map strata. If the strata were significantly different, based on the ANOVA (alpha < 0.05), then Tukey's Studentized Range test was used to determine which strata differed (alpha = 0.1) for the tree size class. This analysis identified the map strata that were statistically different for at least 1 tree size-class variable. In addition, we identified the variable means that were significantly different in the comparison.

JOB 3. HABITAT CAPABILITY MODEL EVALUATION

The habitat capability model for martens in Southeast Alaska, developed by an interagency group of biologists (Suring et al. 1992), will be evaluated in 2 ways using the general considerations listed by Schamberger and O'Neil (1986). During model testing, we will compare habitat coefficient values with observed habitat selection indices. Habitat selection indices for fall/winter/spring will be compared to habitat capability coefficients in the marten habitat capability model (Suring et al. 1992). We will compare the estimated density of adult resident martens on the primary study area to values predicted by the model.

JOB 4. POPULATION ECOLOGY

Each study area was live-trapped intensively during October and March to determine the sex and age composition of the martens. We recorded the time and location of all known deaths of radiocollared martens. We attempted to retrieve the carcasses of martens that died naturally and examined them for cause of death. We obtained the carcasses of many trapper-caught study animals. These carcasses were processed according to procedures established for the general collection of trapper-caught carcasses.

We surveyed martens on the Salt Lake Bay study area using mark–recapture methods (Seber 1982, White and Garrott 1990). For the survey, we considered captured martens marked with only eartags or wearing failed collars as new individuals. Based on our earlier radiotracking data, we assumed the population was closed (without emigration or immigration) during the 5-day trapping session and each animal had an equal probability of being captured at least once during the trapping session. The study area was defined by the composite home ranges of resident martens (84 km^2). We computed a Lincoln–Petersen estimate of population number for a closed population, single mark-release experiment for each trapping session. Shortly before or after a trapping session, we located the radiocollared martens on the study area to determine the number of marked animals present during the trapping session. In the mark–recapture analysis, we used the number of radiocollared martens on the study area during the trapping session as n_1, the total number of martens captured as n_2, and the number of radiocollared martens recaptured as m_2. We used an Excel spreadsheet (Sterling Miller, pers commun, ADF&G, Anchorage), for the numeric analyses, including the population estimate, variance, and 95% confidence intervals from normally distributed data. In addition, we determined the minimum number of martens on the study area during the trapping session by adding the number of new captures to the number of previously radiocollared animals present. At this point, we have not determined whether all of the assumptions for a Lincoln–Petersen mark–recapture experiment were met in this situation. We will further evaluate the appropriateness of our methods.

We attempted to collect the carcasses of all martens caught by trappers on northern Chichagof Island. Before the opening of the 1 December trapping season, we contacted trappers in Hoonah and Tenakee Springs and offered them $3.00 for each marten carcass delivered to us. Trappers were instructed to record the date and location of each capture and to freeze the carcasses immediately after skinning. Upon receiving the carcasses from the trappers, we kept them frozen until processing.

We weighed each carcass and assigned an index of internal and external fat content, using an ocular estimation procedure developed by Blundell and Flynn (1992, unpubl. report, ADF&G, Douglas, AK). We measured each skull according to Magoun et al. (1988) and classified the animal as juvenile or adult. We heated the skulls in water for 3 hours at 70° C, then extracted the lower canine and lower fourth premolar teeth. The teeth were stored frozen until sent to Matson's Laboratory (Milltown, MT) for age determination by cementum analysis (Poole et al. 1994). We measured total, body, and tail lengths of each carcass, recording the method of skinning (i.e., feet skinned out or not). We examined the stomachs of each carcass for the presence of parasites, especially *Soboliphyme baturini* worms. We extracted the ovaries from the reproductive organs of females and preserved them in 10% formalin. All ovaries were washed in tap water, then sent to Matson's Laboratory (Milltown, Montana USA) for evaluation for the presence and number of corpora lutea (Strickland and Douglas 1987).

JOB 5. MOVEMENTS AND SPATIAL PATTERNS

Radiocollared martens were located from small aircraft, usually a Super Cub, about once every 2 to 4 weeks to monitor general movements (Kenward 1987). Aerial locations were plotted on high-resolution orthophoto maps (1:31,680 scale) and digitized as stateplane coordinates using a PC-based GIS computer program. We will model home ranges of resident martens using either the computer program HOME RANGE (Ackerman et al. 1990) or RANGES V (Kenwood and Hooder 1996). Locations were tested for independence (Swihart and Slade 1985) and outliers examined (Samuel et al. 1985). We will calculate the area of home ranges using 90 and 100% convex polygons and adaptive kernel estimates.

We spent little effort radiotracking transient martens this year. From aircraft we searched the entire northeastern portion of Chichagof Island every few months to locate transient martens. We recorded the maximum distance traveled from initial capture sites and the maximum distance between relocations for each transient animal.

JOB 6. SMALL MAMMAL ABUNDANCE

We estimated the abundance of small mammals, excluding red squirrels, using a snap-trap index (Calhoun 1948). Transects were established in 3 stands: a productive western hemlock old-growth stand; an unproductive, mixed conifer/blueberry old-growth stand; and a 9-year-old clearcut. We established 25 stations along each transect at 15-m intervals. Two Museum Special snap traps were placed at each station, baited with a mixture of peanut butter and rolled oats, and set for 3 consecutive nights (450 trap nights). We operated the traplines in September when small mammal populations were at their annual peak. We recorded the number of animals of each species caught per 100 trap nights.

JOB 7. SEASONAL DIETS

We collected marten scats at trap sites and opportunistically along roads and trails while working in the field. The scats were labeled and frozen for future analyses. The scats will be examined for frequency of prey items.

Beginning in fall 1992, we drew a 2 to 3 cc sample of blood from the jugular vein of most captured martens. At camp the blood was spun at 3000 rpm in an electric centrifuge and the serum siphoned into a separate vial. The clotted blood cells were stored frozen and sent to Merav Ben-David, University of Alaska Fairbanks, for analysis of the stable isotopes of carbon and nitrogen (Schell et al. 1988, Ben-David et al. 1997).

JOB 8. EVALUATION OF FIELD SEXING AND AGING TECHNIQUE

We collected marten skulls from trappers operating on northern Chichagof Island to evaluate the field technique for sexing and aging martens proposed by Magoun et al. (1988). We recorded total skull length and length of temporal muscle coalescence for each specimen according to procedures of Magoun et al. (1988). A lower canine tooth and a lower fourth premolar were extracted from each skull for age determination by cementum analysis (Matson's Laboratory, Milltown, MT). We will compare the skull measurements according to Magoun et al. (1988).

RESULTS AND DISCUSSION

During 1997–1998, we captured 25 martens (14 males and 11 females) on the Salt Lake Bay study (Tables 2, 3). Five of these martens (males) were captured for the first time this year. We radiocollared only 4 of the new martens (1 male, 3 females) and put radio collars on 2 martens (females) for the first time; these martens had previously been eartagged. In upper Game Creek we caught an additional 10 martens (6 males and 4 females). Only 1 male had previously been captured. All captured martens were weighed and measured; they were aged by cementum analysis. We did not trap in the drainages of Freshwater Bay or Indian River this year.

JOB 1. HABITAT USE

During the year from small aircraft, we located 33 radiocollared martens (22 males and 11 females) 200 times. The location information was recorded, plotted on aerial photographs, and entered into a GIS computer file. We did not complete any additional analyses for this report. More information on the selection of habitats will be included in the final report in 2000.

Den Sites

We located marten dens opportunistically during 1994 and 1995 and found 5 natal and 5 maternal dens. During 1996 and 1997 we monitored all adult radiocollared females (5 and 6, respectively) to locate dens. During these years, only 1 female actually denned each year, and we located 2 natal dens and 1 maternal den. Neither of these litters survived to independence. Several other females may have initiated dens, but these apparently failed before we could detect kits or evidence of denning behavior. We speculated that a decrease in the availability of prey, particularly long-tailed voles, might have led to the failure to produce young. Diet data from previous years have shown voles are the principal prey of martens on northeastern Chichagof Island during spring and early summer (Ben-David et. al 1997).

We spent considerable time locating marten dens in the spring and early summer of 1998. During early April and May, we live trapped in both of the study areas to increase our sample of radiocollared adult females. We captured only 4 new adult females, reflecting the low number of adult females on the study area. Two of these females (#173 and #219) had been previously captured (eartagged) as adults. The 2 untagged adult females (#298, #299) were transients and promptly left the study area.

We monitored 8 radiocollared adult females (#120, #128, #149, #163, #173, #188, #189, #219) during part of the denning period, 5 at SLB and 3 at Game Creek. On April 20, female #189 was located on mortality mode at high elevation in an avalanche slope, an apparent natural death. Of the 7 surviving radiocollared adult females, 5 females had active dens (#120, #128, #149, #163, and #173). We located 8 natal dens and 8 maternal dens used by these females. We stopped monitoring the females in early July, so we do not know how many reared young to independence.

Of the 15 natal dens located since 1994, 4 were in cavities in live trees, 3 were in snag cavities, 5 were in hollow logs, and 3 were in root cavities (Table 4). Diameters of these structures ranged from 60 to 148 cm. Of the 14 maternal dens located, 8 were in root cavities beneath live trees or snags, 4 were in hollow logs, and 2 were in logging slash. Diameters of used structures ranged from 50 to 150 cm.

Martens used 6 types of structures for dens and resting sites (Table 4). Of these, root cavities and arboreal cavities within the boles of live trees and snags were most common. Martens rarely used logs as resting sites, but 35% (9) of all dens were within logs, and 56% (5) of those were natal dens. Root cavities were used at 8 (57%) of 14 maternal dens.

We sampled the vegetation around 13 of the den sites that have been located since 1995. For 8 den sites associated with live trees or snags, the mean dbh of the trees was 110 cm (SD = 36) (Table 5). The mean dbh of the 5 dens in down logs was 91.2 cm (SD = 38). We will analyze these data further for the final report.

We identified tree species of structures associated with dens in all cases. However, we could not determine species for 19 of 51 resting structures because of their advanced state of decay. Structures of unknown species were excluded from the analysis by species. We found no difference in tree species selected at dens compared to those at resting sites ($\chi^2_6 = 2.617$, $P = 0.526$). Overall, martens appeared to use structures of each species at dens and resting sites in proportion to their occurrence.

Martens selected features with different decay classes at dens compared to resting sites ($\chi^2_4 = 14.548$, $P = 0.002$). Over 50% of dead denning structures were in decay classes 1 or 2, whereas 92% of dead resting structures fell within decay classes 4 or 5.

We selected the following habitat attributes for further analysis: diameter at breast height (DBH) of tree/snag and the large-end diameter of log boles (LED). The tree/snag DBH and the LED of logs associated with dens and resting sites were significantly different from other similar structures available within the surrounding 7.3-m-radius circle (Table 6). In general, the structures used by denning martens were double the mean size of available structures. However, we found no significant difference between the mean DBH or LED of structures within 7.3-m-radius patches around dens compared to those around resting sites (LED $t = 0.184$, $df = 15$, $P = 0.4$; and DBH $P = 0.08$) (Table 7).

Resting Sites

Martens used more live trees as resting sites in summer than in winter, and males often rested on the ground among dense understory vegetation in summer. In winter, martens most often rested in root cavities, snags, and underground sites.

We located 19 winter and 17 summer resting sites used by male and female martens and sampled the vegetation around each site, using the same procedures as for the random sites. The structures used for resting were usually cavities in live trees or snags; some were in down logs. All the structures were characteristic of old-growth forest. For 36 resting sites associated with trees or snags, the mean dbh was 66.9 cm (SD = 30). The mean dbh of the 3 resting sites in down logs was 87.3 cm (SD = 33). These data will be further analyzed for the final report.

JOB 2. HABITAT COMPOSITION

During summer 1998 we sampled the landcover at 46 field sites. For the entire study, we sampled 65 stratified random locations and 67 sites centered on marten dens or resting sites. With the completion of this season's fieldwork, we exceeded our original target of 64 random sites. Because of the selection criteria, each random polygon contained only 1 type of size/structure pixel. However, the marten den/rest sites always contained several pixel types (2 to 7). Often, these polygons contained a variety of pixel types and varying proportions of pixel types. The map labels assigned to the mixed-pixel polygons depended on the labeling rules developed by Pacific Meridian Resources (1995). Because we did not change the labeling rules, we did not investigate how changing labeling rules affects outputs.

Accuracy Assessment

For 65 random sites, the field label exactly matched the map label 55 times (85%) (Table 8). For only forest strata, the exact match was 78% (32 of 41). In each of the mismatches, the labels differed by only 1 size class. We found the poorest accuracy within the medium/MS (exact = 63%) and intermediate/MS (exact = 67%) strata. These strata appeared to be the most variable and difficult to map accurately. Fehringer (1997) also found relatively low map accuracy for the intermediate/MS type (acceptable = 63%). Additional plots are needed in these types to better determine whether they are "good" landcover types. The nonforest and small/MS strata were nearly 100% accurate. The LANDSAT TM procedures appeared to map these types well. We eliminated salt water from our study area because salt water can be accurately mapped from other GIS coverages. We mapped recent clearcuts from the USFS GIS coverage, so these sites were not used in the AA evaluation. Many of the recent clearcuts were logged since the time of the LANDSAT TM image (August 1992).

Generally, we found greater overall map accuracy than reported by Pacific Meridian Resources (1995) and Fehringer (1997). We may have found greater map accuracy because our random sites were selected from homogenous areas greater than 1.2 ha. In addition, our sites were field-visited and tree attributes were measured. The AA sites selected for the original pilot project (Pacific Meridian Resources 1995) and supplemented by Fehringer (1997) were generally more heterogeneous than our random sites. In addition, the map labels for these sites depended on the labeling procedures for mixed-pixel polygons.

Our data indicated that the LANDSAT TM mapping procedures mapped larger (>1.2 ha), homogenous areas more accurately than heterogeneous areas. In addition, the polygon labeling rules for mixed-pixel areas may need additional evaluation.

Habitat Attributes

We considered the mean numbers of trees and snags per plot by size class as a measure of habitat structure. We did not separate the trees by species or report live trees and snags separately. Other habitat attributes were measured (i.e., stumps, logs and understory), but these data were not summarized for this report. These forest attributes all contribute to habitat quality for old-growth associated species.

The means for the tree-class variables by landcover strata for the random sites (Table 9) were similar with the den/rest sites (Table 10) (*t*-tests, alpha = 0.05). Consequently, we combined the random and marten den/rest sites for the remainder of the analyses (Table 11).

The landcover strata were significantly different for tree-class variables (ANOVA, alpha = 0.05). Because of the numerous comparisons, we summarized the landcover strata that differed by tree-class variable (Tables 12, 13). Generally, Large/MS sites had more large trees and fewer intermediate and small trees. Medium/MS sites were well stocked with many trees of all size classes. Intermediate/MS sites were highly variable. Some sites had clumps of larger trees mixed with intermediate and small trees. Some Intermediate/MS sites had only intermediate and smaller trees. Also, several of the intermediate/MS sites were misclassified; these sites added substantial variance to data for this stratum. Small/MS sites had few large trees and numerous small trees.

Some of the differences were obvious. The nonforest stratum had few trees of any size and differed from most other forest strata for nearly all variables. The singlestoried sites we measured differed from all others because of the large number of intermediate and small trees present. Four of the singlestoried sites resulted from natural wind throw, three resulted from about 35-year-old clearcuts, and 1 was a misclassified small stand.

The magnitude of the differences among means was large in some cases, but the differences were not statistically significant because of large variances or small sample sizes. The Intermediate/MS strata was the most variable and not different from Medium/MS or Small/MS strata. The other multistory strata were different for at least 1 tree-class variable. Large/MS differed from Medium/MS (fewer intermediate trees), Intermediate/MS (more large trees), and Small/MS for 2 variables (more large trees, fewer small trees). Medium/MS was also different from Small/MS (more large and intermediate trees).

JOB 3. HABITAT CAPABILITY MODEL EVALUATION

In a previous progress report (Flynn 1991), we compared the habitat selection indices from this study to the habitat capability coefficients in the habitat capability model. No additional analyses were completed during this report period.

JOB 4. POPULATION ECOLOGY

Of the 33 radiocollared martens monitored at least part of the year, 22 were males and 11 were females. We were not able to radiocollar all resident martens. Some of the eartagged martens were subsequently captured on the study area, indicating they were probably residents.

We had two good opportunities for mark–recapture trapping sessions during the year during October 1997 and March 1998. In October, we recaptured 16 animals (83% of the radiocollared animals present on the study area) and estimated that 19 martens were present. During our April session, we captured 11 martens (71% recapture rate) and estimated that 15 animals were present. These data will be further analyzed for the final report.

JOB 5. MOVEMENTS AND SPATIAL PATTERNS

We located 31 radiocollared martens 200 times to collect information on movements and spatial use patterns. The data were recorded and entered into a GIS data file. Next year, we will use GIS software to complete a comprehensive analysis of the movements and spatial use data.

JOB 6. SMALL MAMMAL ABUNDANCE

During September 1997, we trapped the 4 permanent trend transects at Salt Lake Bay and the 4 transects at Game Creek. At Salt Lake Bay we captured 51 Keen's deer mice, four long-tailed voles, and 6 masked shrews in 600 trap nights. On transects 1–3 we caught 25 rodents in 450 trap nights (5.6 captures/100 trap nights). The snap-trap index indicated small mammal numbers decreased 40% from fall 1996. The index decreased for the third year in a row from a high of 26.9 captures/100 trap nights in 1994. The abundance of deer mice remained about the same, but the catch of long-tailed voles decreased 82% (5.1 to 0.9 captures/100 trap nights).

On the Game Creek transects, we caught 36 deer mice, 6 long-tailed voles, and 3 masked shrews in 600 trap nights. On the 4 transects (nr 3–6) combined, we caught 42 rodents in 600 trap nights (7.0 captures/100 trap nights). The snap-trap index indicated rodents numbers decreased for the third year from a high of 26.8 captures/100 trap nights in 1994 and 52% from fall 1996. Here, the index for deer mice decreased along with the index for long-tailed voles. The index for deer mice decreased 29% (8.5 to 6.0) and voles decreased 84% (5.1 to 0.9 captures/100 trap nights).

Because vole numbers decreased sharply in each study area (about 80%), the availability of an important food for martens was probably greatly reduced on northeast Chichagof Island during 1997–1998.

JOB 7. SEASONAL DIETS

No additional results were available. Previous results were published (see below).

JOB 8. EVALUATION OF FIELD SEXING AND AGING TECHNIQUE

We updated the data files, but no additional analyses were completed. We now have data on over 3000 martens. These data will be evaluated for the final report.

JOB 9. SCIENTIFIC MEETINGS AND WORKSHOPS

We attended no scientific meetings during the report period

JOB 10. REPORTS AND SCIENTIFIC PAPERS

Ben-David, M., R. Flynn, and D. M. Schell. 1997. Annual and seasonal changes in diets of martens: evidence from stable isotope analysis. *Oecologia* 111:280–291.

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Table 1 Current composition of the Salt Lake Bay-Game Creek study area by LANDSAT TM size/structure strata, northeast Chichagof Island, Southeast Alaska

Strata	Map code	Nr of polygons > 1.2 ha	Area (acres)	Area (ha)	Percent (%)
Large/multistoried	13	291	5,822	2,356	11.8
Medium/multistoried	14	479	10,408	4,212	21.1
Intermediate/multistoried	15	327	7,627	3,087	15.5
Small-pole/multistoried	16,17	214	6,341	2,566	12.9
Singlestoried	6,7,8,9	46	1,435	581	2.9
Shrub	4	142	8,603	3,482	17.5
Other nonforest	2,3,5	155	5,108	2,067	10.4
Recent clearcuts[a]	18	89	3,895	1,576	7.9
Totals		1,743	49,239	19,927	100.0

[a] Derived from USFS GIS data files, a subset of Other nonforest (6.4%), Shrub (34.0%), Large/MS (12.9%), Medium/MS (21.2%), Intermediate/MS (7.4%), Small/MS (3.8%), and Singlestoried (9.1%) strata.

Table 2 Age, sex, and status of radiocollared martens monitored on northeast Chichagof Island, 1997–1998

Animal nr	Sex	Age class	Date first radiocollared	Nr of captures	Study[a] area	Residency[b] status	Survival status[c]
120	F	5	02/15/94	1	SLB	R	Survived
124	M	4	04/02/94	1	SLB	T	Censored
128	M	4	10/22/94	8	SLB	R	Survived
163	F	4	03/21/97	2	SLB	R	Survived
173	F	6	04/07/98	1	SLB	R	Survived
179	M	2	12/12/94	1	SLB	R	Censored
184	F	3	07/21/95	4	SLB	R	Survived
188	F	2	10/07/95	6	SLB	R	Survived
191	M	2	05/30/97	8	SLB	R	Survived
193	M	1	03/23/95	14	SLB	R	Survived
196	M	1	10/01/96	4	SLB	R	Trapped -December
216	M	1	10/12/96	4	SLB	R	Censored
219	F	4	04/09/98	1	SLB	R	Survived
220	F	3	05/28/97	2	SLB	R	Natural death
233	F	3	06/15/97	3	SLB	R	Censored
236	M	3	04/29/97	4	GC	R	Survived
275	M	1	06/14/97	0	SLB	R	Censored
282	M	3	05/26/97	3	SLB	R	Survived
289	F	4	09/25/97	1	SLB	R	Natural death
297	F	2	04/07/98	1	SLB	T	Censored
298	F	2	04/08/98	1	SLB	T	Censored
299	M	1	06/13/98	3	SLB	R	Survived

[a] SLB = Salt Lake Bay and GC = Game Creek.

[b] R = resident or T = transient.

[c] The animal was considered censored for the survival analysis when the radio signal was not found after the month listed.

Table 3 Age and sex of other martens captured on northeast Chichagof Island, 1997–1998. These individuals were marked with only eartags.

Animal nr	Sex	Age class	Date first captured	Nr of captures	Study[a] area	Status
283	F		08/29/97	1	GC	Unknown
284	F	1	08/31/97	3	GC	Unknown
285	M	2	09/10/97	2	GC	Unknown
286	F	3	09/18/97	1	GC	Unknown
287	F	2	09/18/97	1	GC	Unknown
288	M	1	09/25/97	3	GC	Unknown
290	M	2	09/26/97	1	GC	Unknown
291	M	2	09/26/97	1	GC	Unknown
292	M	0	09/27/97	1	GC	Unknown
293	M	2	10/19/97	3	SLB	Unknown
294	M	2	10/20/97	4	SLB	Unknown
295	M	0	10/21/97	2	SLB	Unknown
296	M	0	10/22/97	2	SLB	Trapped
300	M	3	04/10/98	1	SLB	Unknown

[a] GC = Game Creek; SLB = Salt Lake Bay

Table 4 Types of structures used as dens and resting sites by martens on northeastern Chichagof Island, Alaska, 1994–98

Structure	Dens	Resting Sites					All sites
		All	Summer	Winter	Male	Female	
Live tree	4 (14%)	5 (9%)	4	1	1	4	9 (11%)
Snag	3 (10%)	6 (11%)	4	2	1	5	9 (11%)
Log	10 (34%)	5 (9%)	5	0	1	4	15 (18%)
Root cavity	11 (38%)	24 (44%)	11	13	6	18	35 (43%)
Underground[a]	0	4 (7%)	2	2	0	4	4 (5%)
Logging Slash	1 (3%)	0 (2%)	0	0	0	0	1 (1%)
Stump	0	5 (9%)	2	3	2	3	5 (6%)
No structure[b]	0	4 (7%)	4	0	3	1	4 (5%)
Totals	29	53	32	21	15	32	82 (100%)

[a] Includes CWD under the surface of the ground or underground cavities created by decaying roots or logs.
[b] Sites where martens were lying on the surface of the ground not associated with any structure.

Table 5 Mean (SD) DBH (cm) of vertical woody structures used as dens and resting sites versus other structures available within a 7.3-m-radius circle on northeastern Chichagof Island, Alaska, 1994–98

Site type	Used			Available		
	$\bar{x}$	SD	*n*	$\bar{x}$	SD	*n*
Dens	109.5	35.9	8	44.7	13.1	8
All resting sites	72.4	33.9	29	35.3	9.5	29
Summer resting sites	80.6	38.8	13	33.8	10.0	13
Winter resting sites	65.8	28.9	16	36.4	9.2	16
Male resting sites	61.7	19.6	9	37.9	8.8	9
Female resting sites	77.5	37.2	21	33.8	9.6	21

Table 6 Mean (SE) diameters (cm) of the large end of logs used as marten dens and resting sites compared with means for the study area on northeastern Chichagof Island, Alaska, 1994–1998

Site type	Used			Available		
	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*
Den sites	87	9.0	10			
Resting sites	89	10.4	5			
All sites	88	6.7	15	36	1.3	48

Table 7 Mean (SE) structure sizes within a 7.3-m radius around dens and resting sites used by martens on northeastern Chichagof Island, Alaska, 1994–98

Site attribute	Dens			Resting Sites		
	$\bar{x}$	SE	*n*	$\bar{x}$	SE	*n*
DBH vertical structure (cm)	43	2.7	28	40	1.9	38
Dia. large end of log (cm)	35	4.4	28	33	2.7	38

Table 8 Number of random field plots and exact matches with LANDSAT TM size class map

Landcover strata	Code	Nr of sites	Exact [a] matches	Percent
Shrub	4	8	8	100
Singlestoried	7,8	8	7	88
Large/MS	13	8	7	88
Medium/MS	14	8	5	63
Intermediate/MS	15	9	6	67
Small-pole/MS	16, 17	8	7	88
Recent clearcuts	18	8	8	100
Other nonforest	2,3,5	8	7	88
Total		65	55	85

[a] Considering only forested types, the percentage of exact matches was 78%.

Table 9 Number of trees/snags by size class by LANDSAT TM mapped size strata for random sites, northeast Chichagof Island, Southeast Alaska. Plots represent the aggregation of 4 0.017-ha subplots per site or 0.07 ha

Landcover strata	No. plots	No. large[a] trees		No. medium[b] trees		No. interm.[c] trees		No. small[d] trees		No. pole[e] trees	
		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Shrub	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Singlestoried	8	0.4	0.3	1.9	0.7	9.0	2.0	22.2	2.9	32.1	8.0
Large/MS	8	2.9	0.5	3.0	0.9	5.0	0.8	7.8	2.1	8.4	2.7
Medium/MS	8	2.0	0.6	2.8	0.7	7.1	1.4	9.5	1.1	14.0	2.5
Intermediate/MS	9	1.2	0.6	2.6	0.7	6.6	0.9	10.4	1.9	15.6	4.0
Small-pole/MS	8	0.4	0.2	0.8	0.6	2.5	0.9	12.9	2.8	17.9	2.6
Recent clearcuts	8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Other nonforest	8	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.6	0.6

[a] Large trees > 819 mm diameter at breast height (dbh)
[b] Medium trees = 590–819 mm dbh
[c] Intermediate trees = 385–589 mm dbh
[d] Small trees = 230–384 mm dbh
[e] Pole trees = 125–229 mm dbh

Table 10 Number of trees/snags by size class by LANDSAT TM mapped size strata for marten den/rest sites, northeast Chichagof Island, Southeast Alaska. Plots represent the aggregation of 4 0.017-ha subplots per site or 0.07 ha

Landcover strata	Nr plots	No. large[a] trees		Nr medium[b] trees		Nr interm.[c] trees		Nr small[d] trees		Nr pole[e] trees	
		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Shrub	0										
Singlestoried	0										
Large/MS	9	2.8	0.7	2.7	0.4	3.0	0.7	4.9	0.9	7.3	2.0
Medium/MS	20	2.4	0.4	3.2	0.4	5.3	0.8	7.8	1.1	13.5	2.4
Intermediate/MS	21	1.4	0.4	2.7	0.5	5.8	0.7	10.4	1.3	14.7	1.7
Small-pole/MS	9	0.7	0.4	2.1	0.4	5.9	1.1	12.4	2.2	16.6	2.4
Recent clearcuts	7	0.0	0.0	0.8	0.6	1.3	0.8	1.7	1.2	2.8	1.5
Other nonforest	0										

[a] Large trees > 819 mm diameter at breast height (dbh)
[b] Medium trees = 590–819 mm dbh
[c] Intermediate trees = 385–589 mm dbh
[d] Small trees = 230–384 mm dbh
[e] Pole trees = 125–229 mm dbh

Table 11 Number of trees/snags by size class by LANDSAT TM mapped size strata for all sites, northeast Chichagof Island, Southeast Alaska. Plots represent the aggregation of 4 0.017-ha subplots per site or 0.07 ha

Landcover strata	Nr plots	Nr large[a] trees		Nr medium[b] trees		Nr interm.[c] trees		Nr small[d] trees		Nr pole[e] trees	
		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Shrub	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Singlestoried	8	0.4	0.3	1.9	0.7	9.0	2.0	22.2	2.9	32.1	8.0
Large/MS	17	2.8	0.4	2.8	0.5	3.9	0.6	6.2	1.1	7.8	1.6
Medium/MS	28	2.3	0.3	3.0	0.3	5.8	0.7	8.3	0.8	13.6	1.8
Intermediate/MS	30	1.3	0.3	2.6	0.4	6.0	0.6	10.4	1.0	14.9	1.7
Small-pole/MS	17	0.5	0.2	1.5	0.4	4.3	0.8	12.6	1.7	17.2	1.7
Recent clearcuts	15	0.0	0.0	0.5	0.3	0.6	0.4	0.8	0.6	1.5	0.8
Other nonforest	8	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.6	0.6

[a] Large trees > 819 mm diameter at breast height (dbh)
[b] Medium trees = 590–819 mm dbh
[c] Intermediate trees = 385–589 mm dbh
[d] Small trees = 230–384 mm dbh
[e] Pole trees = 125–229 mm dbh

Table 12 Mean numbers of trees/plot by tree size class for each map strata. All map strata differed significantly for at least one tree-class variable (ANOVA, alpha = 0.01)

Tree-class variable[1]	Strata means[2]					
Nr large trees						
	Large/MS	Medium/MS	Intermediate/MS	Small/MS	SS	NF
	2.8^{a}	2.3^{ab}	1.3^{bc}	0.5^{cd}	0.4^{cd}	0.0^{d}
Nr medium trees						
	Medium/MS	Large/MS	Intermediate/MS	SS	Small/MS	NF
	3.0^{a}	2.8^{ab}	2.6^{ab}	1.9^{abc}	1.5^{bc}	0.0^{c}
Nr intermediate trees						
	SS	Intermediate /MS	Medium /MS	Small/MS	Large/MS	NF
	9.0^{a}	6.0^{ab}	5.8^{ab}	4.3^{b}	3.9^{b}	0.1
Nr small trees						
	SS	Small/MS	Intermediate/MS	Medium/MS	Large/MS	NF
	22.2	12.6^{a}	10.4^{ab}	8.3^{bc}	6.2^{c}	0.4
No. pole trees						
	SS	Small/MS	Intermediate/MS	Medium/MS	Large /MS	NF
	32.1	17.2^{a}	14.9^{ab}	13.6^{ab}	7.8^{b}	1.0

[1] Tree classes defined are as follows: Large trees = number of trees > 820 mm diameter at breast height (dbh); Medium trees = number of trees 590–819 mm dbh; Intermediate trees = number of trees = 385–589 mm dbh; Small trees = number of trees 230–384 mm dbh; Pole trees = number of trees 125–229 mm dbh

[2] Strata means with the same letter were not significantly different (Tukey's Studentized Range test, alpha = 0.1). SS = singlestoried and NF = nonforest strata.

Table 13 Means of vegetative characteristics for each map strata. All map strata differed significantly for at least one tree variable (ANOVA, alpha = 0.01)

Tree variable[1]	Strata means[2]				
Tree height (m)					
Large/MS	SS	Medium/MS	Intermediate/MS	Small/MS	NF
24.7^{a}	22.6^{ab}	20.4^{b}	19.2^{b}	14.5	1.9
QMD (cm)					
Large /MS	Medium/MS	Intermediate/MS	Small/MS	SS	NF
63.3	57.0^{a}	50.4^{ab}	40.9^{ab}	39.4^{b}	9.1
Basal area (m^2)					
Large/MS	Medium/MS	SS	Intermediate/MS	Small/MS	NF
5.03^{a}	4.80^{ab}	4.19^{ab}	3.93^{ab}	2.57^{b}	0.19
Basal area of TSHE (m^2)					
SS	Large /MS	Medium/MS	Intermediate/MS	Small /MS	NF
2.84^{a}	2.58^{ab}	2.00^{bc}	1.47^{c}	0.41^{d}	0.04^{d}
Basal area of CHNO (m^2)					
Small /MS	Medium /MS	Intermediate /MS	Large/MS	NF	SS
1.00^{a}	0.70^{a}	0.61^{ab}	0.08^{bc}	0.02^{c}	0.0
Basal area of TSME (m^2)					
Intermediate/MS	Medium/MS	Large /MS	Small/MS	SS	NF
0.51^{a}	0.50^{a}	0.49^{a}	0.48^{a}	0.16^{b}	0.01

[1] Includes all live and dead tress > 229 mm DBH and >2 m in height. QMD = quadratic mean diameter, TSHE = *Tsuga heterophylla*, CHNO = *Chamaecyparis nootkatensis*, TSME = *Tsuga mertensiana*

[2] Strata means with the same letter were not significantly different (Tukey's Studentized Range test, alpha = 0.1)